

Gold Nanoparticle Doped Polymer Materials for Micro- and Nanofabrication

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New bottom-up approach to fabricate metal nanoparticle doped polymer photoresist (polymer nanocomposite) is presented. The nanocomposite holds a potential to fabricate hierarchically structured materials which have tailored functionalities spanning multiple length, scales and dimensions. Such materials will enable exiting new applications in micro- and nanotechnology¹. However, simple mixture of nanoparticles with many polymers leads to non-uniform distribution, particle clustering or aggregation that impairs desired properties in the composite material².

Gold nanoparticle SU-8 composite was structured by UV photolithography and attained the lithographic resolution of 3.5 μm by soft contact (Figure 1). Point-wise light scattering was observed through dark field microscopy (Figure 2). Plasmonic extinction peaked at 550 nm and similar response was observed by brief Mie calculation at $n=1.63$, (Figure 3). Spherical gold nanoparticle possesses isotropic feature. However, the composite showed polarization dependency to incident light, indicating that the particles were self-organized chemically and/or physically during the fabrication. The material is speculated to be useful in various fields, such as biomedical optics and photonics. The technique may be a break-through for cost-effective and scalable development for plasmonic sensing devices for example, SPR spectroscopy/SERS substrate and ultra-thin photonic crystals which sometimes relay on time consuming top-down approach for the fabrication. Since SU-8, PVP/VA and gold nanoparticles have low biological toxicity there may be applications in life science and medicine with this technique^{4, 5}.

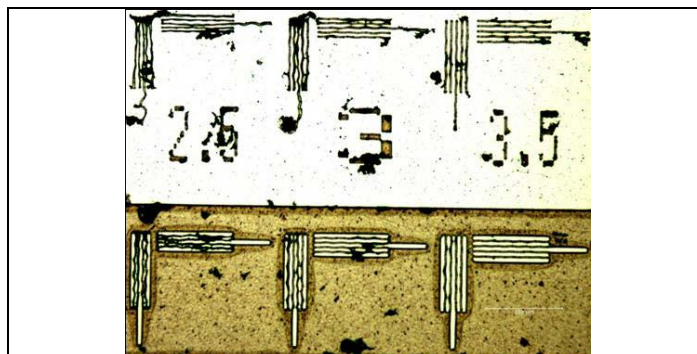


Figure 1: Bright field image from two SU-8 structures.
Lithographic resolution, 3.5 μm was achieved

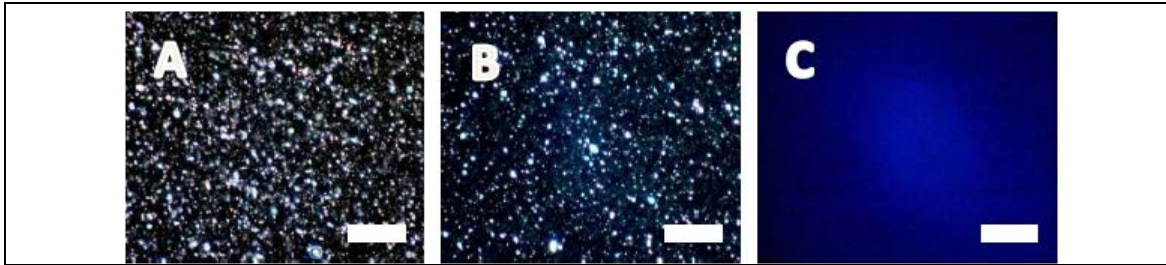


Figure 2: The image from dark field microscopy. From left to right, pictures were taken with (A) 1w/w% (8mg), (B) 0.25w/w (2mg) and (C) control respectively. The white bar is the scale bar (10 μ m).

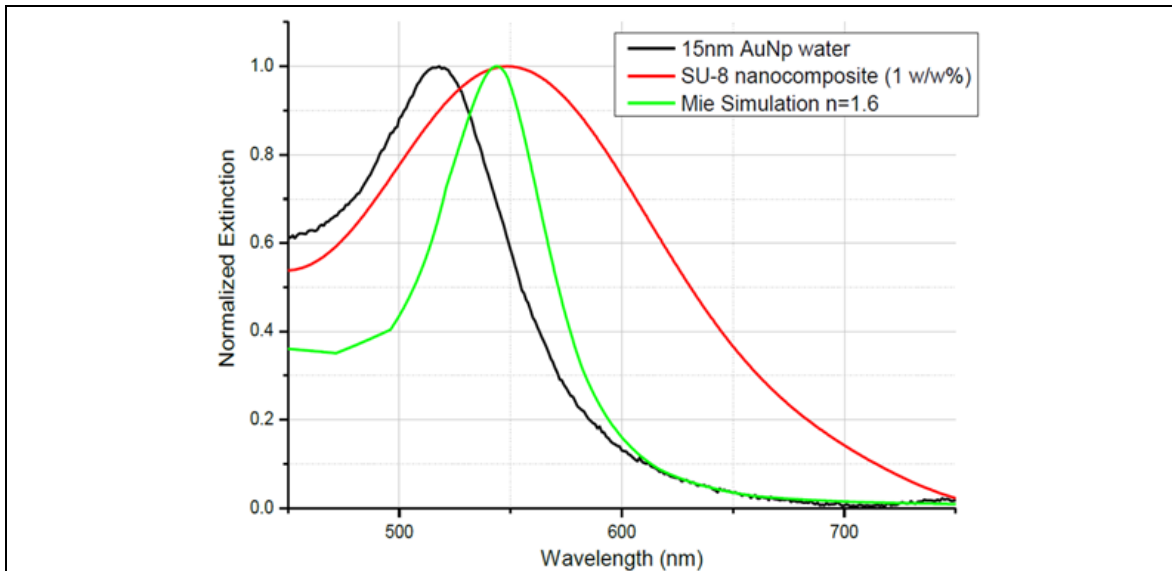


Figure 3: Normalized excitation spectra from 5 μ m SU-8/15nm gold nanoparticle composite. From black, red to green spectra corresponds to phase in water, SU-8 nanocomposite (1 w/w %) and theoretical spectra from 15nm particle at $n=1.6$ respectively.

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